Earth Satellite Direct Broadcast to Direct Readout

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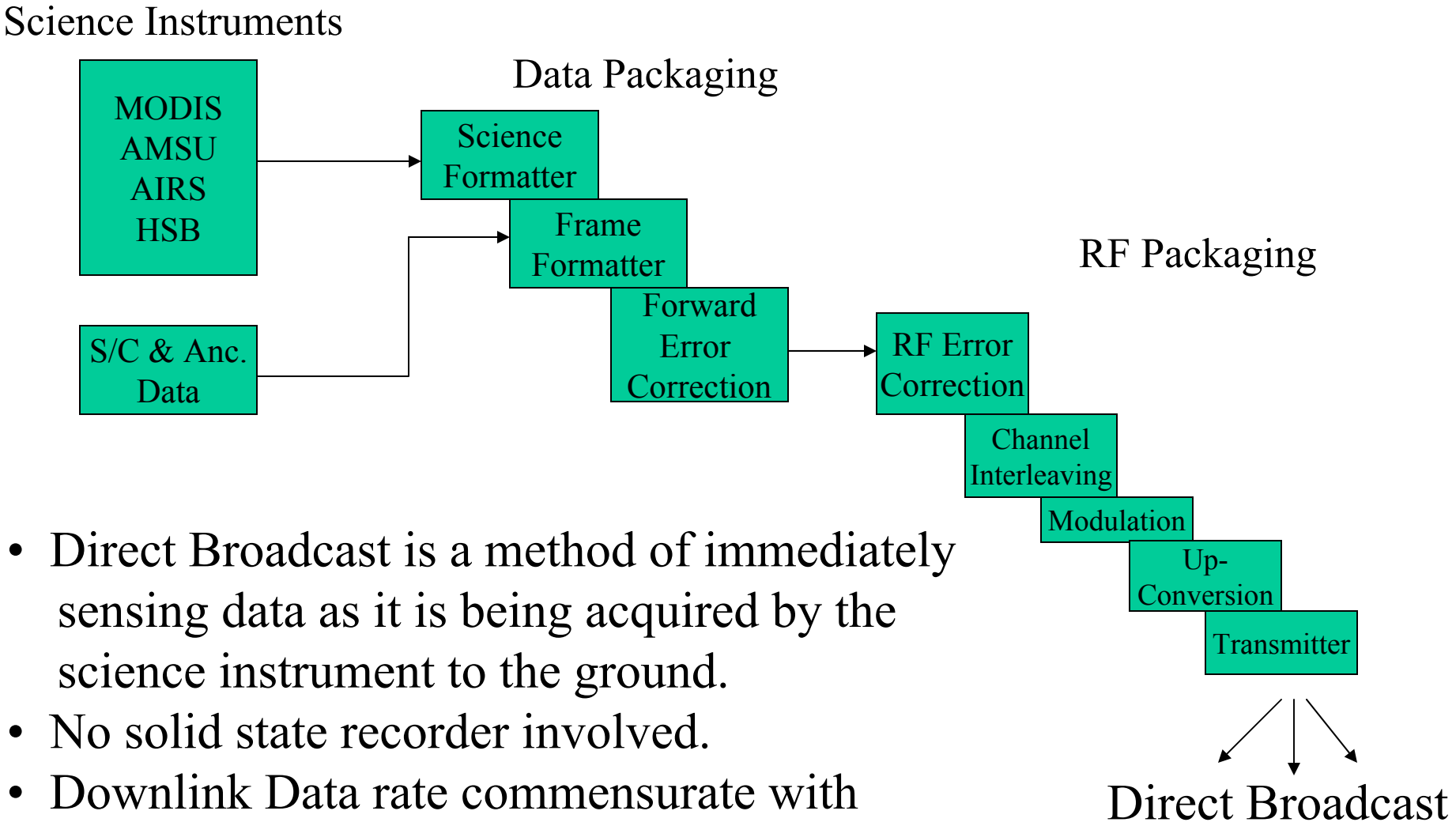
What Makes a Direct Broadcast Satellite



- Direct Broadcast is a method of immediately sensing data as it is being acquired by the science instrument to the ground.
- No solid state recorder involved.
- Downlink Data rate commensurate with aggregate instrument output data rate.

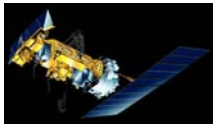
Where are the EOS DB Sites?

- 60 known sites
  - 10 unconfirmed
  - 20 additional to be operational by next year
- 40 currently operational
  - 16 in the U.S.
  - 8 in Russia
  - 5 in Japan, 3 in China (6 more unconfirmed)
  - 3 in Australia
  - 25 in other countries including Singapore, Thailand, Kazhakstan, Korea, India, Brazil, Germany, Italy

EOS Direct Broadcast: Global Coverage

Direct Broadcast Technology *Evolution*

POES/DMSP/SeaStar

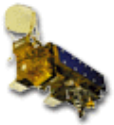


AVHRR
SeaWiFS
OLS

Terra

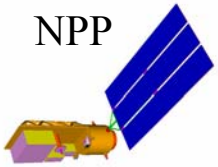
MODIS

Aqua



MODIS
AIRS
AMSU
HSB
CERES

NPP



NPOESS

VIIRS
CrIS
ATMS
OMPS
CERES

S/C & Instrument Evolution

Standardization & Increasing RF, Modulation & Bandwidth Requirements

- L,S-band
- .665 - 2Mbps
- Bi-Phase L

- Custom Frame Formatters & Ingest software
- Analog Custom Receivers
- NOAA Level1B (AVHRR)
- Limited Data Distribution mechanisms

- X-band
- 13.1Mbps
- Viterbi
- OQPSK

- S/C specific STPS
- Level-0
- Return Link Processor
- Analog Configurable Receiver
- MODIS Level-1
- DAAC & MODIS Simulcast

- X-band
- 15Mbps
- OQPSK
- NRZM

- Reconfigurable RT-STPS
- Return Link Processor
- Digital re-Configurable Receiver
- MODIS & AIRS Level-1
- DAAC & NEpster with L0 & L1 data
- Simulcast of MODIS

- X-band
- 15Mbps
- QPSK
- NRZM
- Viterbi
- Compression

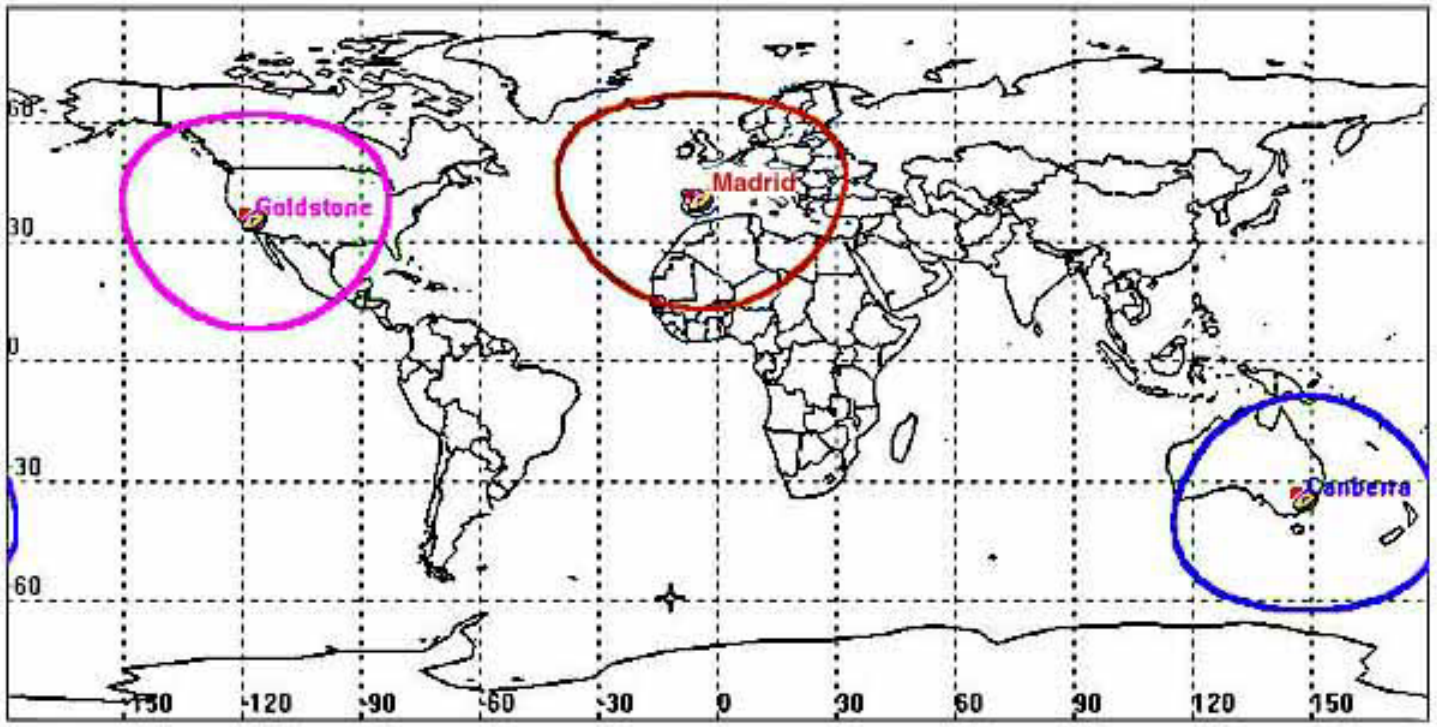
- Reconfigurable RT-STPS
- Digital re-Configurable Receiver (PC-based)
- ALL Instru. Level-1 Software
- DAAC & NEpster with L0, L1 & L2
- Simulcast of any Instruments

Evolution of Concurrent Ground System Supporting Technologies and Algorithm Development

Evolution of Direct Broadcast Transmissions

POES	EOS	NPP
Users: 10k APT; 1500 HRPT Cost: $500 APT; $7k HRPT	Users: 70 Cost: $300k	Users: Legacy + TBD Cost: $200k
HRPT: (L-band Real-Time) Freq: 1698, 1702.5, 1707 MHz Polarization: RHCP Mod: Split-phase PSK Data Rate: 665.4kbps	**Terra:** (X-band Real-Time) Freq: 8212.5 MHz Polarization: RHCP Mod: OQPSK Data Rate: 13.1 Mbps Q:I pwr ratio 4:1 FEC: Viterbi rate 1/2, k-7 I/Q interleaved: no	**HRD:** (X-band Real-Time) Freq: 7812 MHz Polarization: RHCP Mod: QPSK Data Rate: 15 Mbps Q:I pwr ratio 1:1 FEC: Viterbi rate 1/2, k-7 I/Q interleaved: yes
APT: (VHF Real-Time) Freq: 137.50, 137.62 MHz w/2.4kHz subcarrier Mod: AM/FM BW: 2kHz	**Aqua:** (X-band Real-Time) Freq: 8160 MHz Polarization: RHCP MOD: OQPSK Data Rate: 15 Mbps FEC: none Q:I pwr ratio 1:1 I/Q interleaved: yes	

DSN Site Locations and Schedule



Terra DB turn-off schedule based on +/- 5 deg DSN azimuthal pointing

NASA's DR Ground System Development Approach

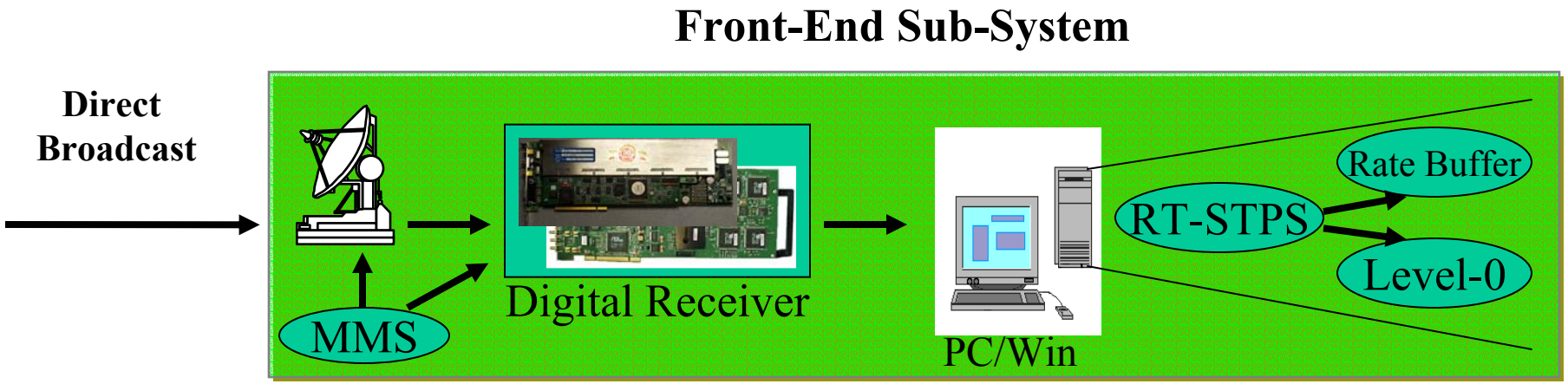
As the Direct Readout Lab (DRL) we provide an environment for the design, development, integration, and testing of standalone technologies. This enables the validation and testing of satellite and instrument-specific hardware, decoding software, and data processing and management systems that are necessary to acquire, process and distribute directly broadcast data.

The purpose of this environment is to provide:

- All necessary hardware and software technologies, knowledge, information, and lessons learned to the general public though technology transfer and public domain releases.
- A guide to the commercial sector on the utility of Earth remote sensing satellites and its instruments.
- Cost saving solutions for the acquisition, processing, and distribution of Earth remote sensing directly broadcast data.
- Recommendations and enable protocol standardization of data encoding and formats.

Providing a bridge between the mission and the public DB end user

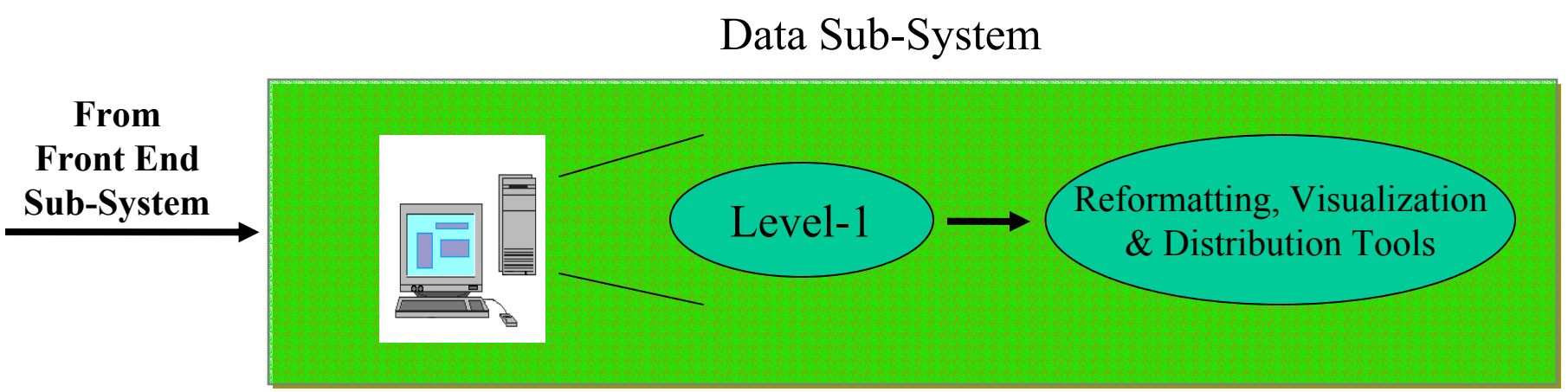
What makes a Direct Readout System
- The Front-End -



Functional Capabilities:

- **Processes DB data through Level-1 in near-real-time**
- **Multi-Mission reconfiguration of antenna tracking, RF hardware and ingest software**
- **Acquires POES & EOS polar orbiting spacecraft**
  - **COTS 2.4 to 3 meter program track system**
- **Ingests up to 25Mbps in software**
- **Real-time packet processing (including RS & PN decoding)**
  - **Simulcasting of instrument data**
- **Performs meta-data generation and reformatting for Level-1 processing (Level-0)**

Direct Readout Back-end Components



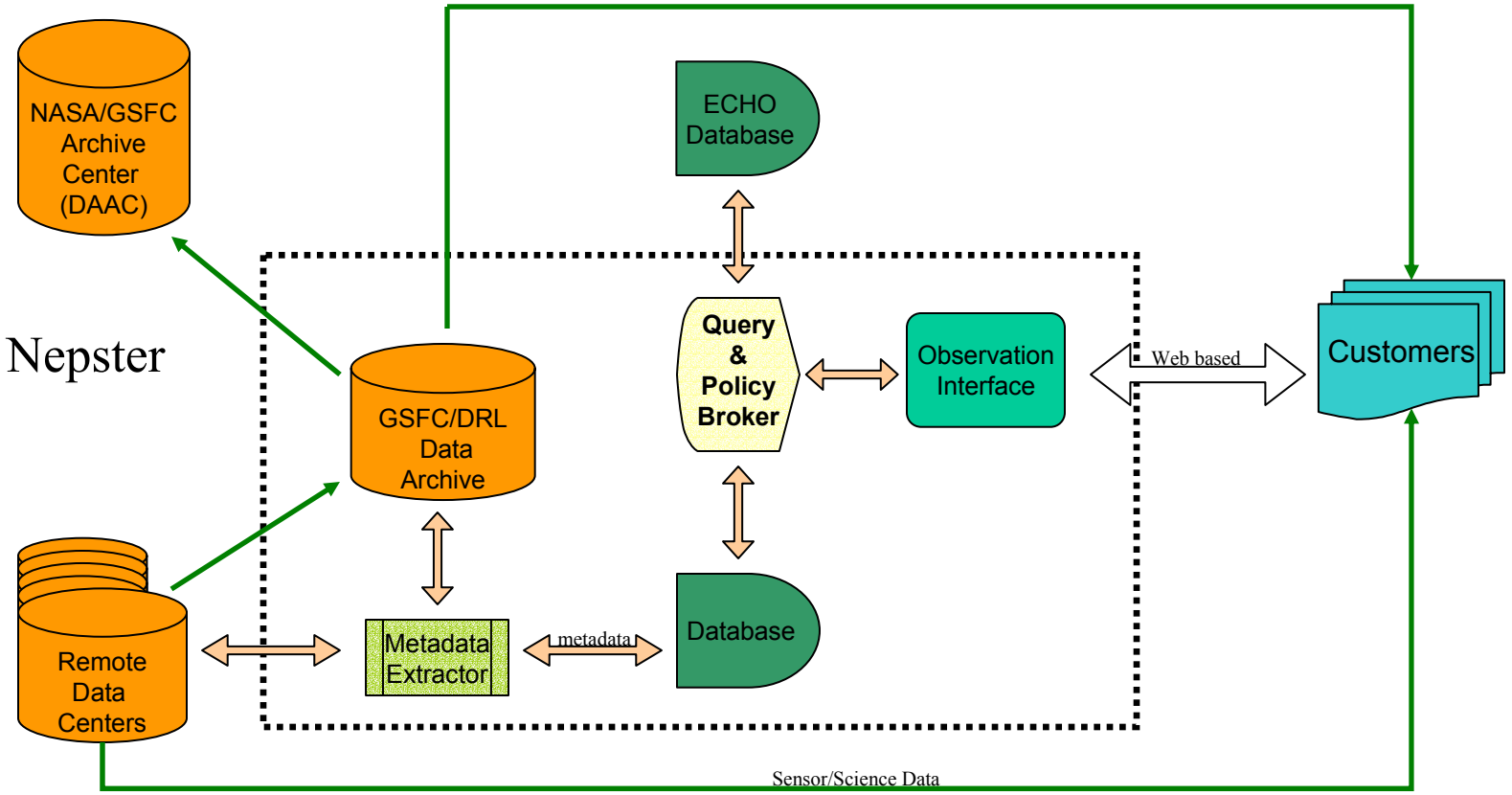
Level-1 Software System:

- **Instrument specific Level-1 algorithms to do data Calibration and Geolocation**

Data reformatting, extracting and distribution tools:

- **User defined instrument image band extraction for visualization**
- **Data reformatting for transportability**
- **Meta-data extraction to enable data query**

NEpster
Real-time Distributed Data Network System



Provides:

- Real-Time notification of data acquisition at a remote site
- A web-based query mechanism for all participating acquisition sites and data repositories
- A temporary archive for remote sites with limited bandwidth
- Automatic routing between the end user and data source

NEpster User Interface